

### **Remarks/Arguments**

Applicants wish to thank the Examiner for the careful review of the claims, specification and drawings.

#### **Claims**

Claim 35, 36, 38, 39, 41, 42, 45, 46, 47, 48, and 49 have been amended.

Claims 37, 40, and 43 have been canceled.

Claim 50 has been added.

After entry of the present amendment, claims 35-36, 38-39, 41-42, and 44-50 are pending.

It is respectfully submitted that each and every feature recited in the amended drawing, specification and/or amended claims are fully supported in the specification as filed. No new subject matter has been added.

#### **Remarks**

#### **Issues under 35 USC 102 (b) and 35 USC 103**

The Examiner rejected claims 35-37 and 39-49 as anticipated by, or in the alternative, under 35 USC 103(a) as being obvious over Turner et al. (US 5576629, hereinafter "Turner").

The Examiner rejected claims 35-49 as anticipated by, or in the alternative, under 35 USC 103(a) as being obvious over Butler et al. (US 5458732, hereinafter "Butler").

The Examiner rejected claims 35-49 as anticipated by, or in the alternative, under 35 USC 103(a) as being obvious over Miyashita et al. (JP 08227875, hereinafter "Miyashita").

The Examiner rejected claim 38 under 35 USC 103(a) as being obvious over Turner in view of Kagoshima et al. (US Pub 2003/0003607, hereinafter "Kagoshima").

The Examiner rejected claims 42 and 49 obvious over Turner in view of Butler.

It is respectfully submitted that none of the art, alone or in combination, discloses that the selection of the appropriate indicator signal hinges on the selection of the appropriate fundamental frequency (such as 2MHz or 27 MHz, for example) among multiple

fundamental frequencies in use, in combination with the selection of the appropriate harmonics (such as second, third, fourth, for example) for that fundamental frequency and the appropriate parameter (such as one of voltage, current, and phase for example).

As discussed in paragraph 33 of the specification as filed:

Referring now to FIG. 5, a graph of phase harmonics waveforms for endpoint detection in accordance with embodiments of the invention is shown and indicated by the general reference character 500. Waveform 502 shows a first harmonic (i.e., fundamental) plot of the phase parameter for an RF frequency of about 27 MHz. From this graph, the endpoint can be determined, as indicated. Waveform 504 shows a 2<sup>nd</sup> harmonic plot of the phase parameter for an RF frequency of about 2 MHz. As can be seen from the figure, the endpoint determination would be more difficult for the about 2 MHz phase parameter 2<sup>nd</sup> harmonic than for the approximately 27 MHz phase parameter fundamental plot. Accordingly, another parameter and/or harmonic may be chosen to determine the endpoint for the approximately 2 MHz RF supply.

In other words, the invention of amended independent claims 35 and 45 not only selects the appropriate harmonics for the appropriate parameter but also selects the correct starting point, i.e., the appropriate fundamental frequency among the plurality of fundamental frequencies.

Amended claim 35 reads as follows.

35. (Currently Amended) A method for selecting an endpoint indicator in plasma processing, the method comprising:
- providing at least a first RF signal having a first fundamental frequency and a second RF signal having a second fundamental frequency at least one frequency;
  - etching, in a plasma processing chamber, at least one sample substrate using the first RF signal and the second RF signal at the at least one frequency;
  - determining at least one calibrating endpoint by performing an empirical analysis on the at least one sample substrate;
  - etching, in the plasma processing chamber, at least one test substrate using the first RF signal and the second RF signal at the at least one frequency, the at least one test substrate being etched beyond the at least one calibrating endpoint;
  - measuring a plurality of parameters at least one parameter over at least one time range when etching the at least one test substrate, the at least one time range including the at least one calibrating endpoint;

comparing data pertaining to at least a first plurality of harmonics for the plurality of parameters and a second plurality of harmonics for the plurality of parameters, the first plurality of harmonics representing frequency harmonics of said first fundamental frequency and the second plurality of harmonics representing harmonics of the second fundamental frequency, the data pertaining to at least sensitivity of the first plurality of harmonics for the plurality of parameters and the second plurality of harmonics for the plurality of parameters responsive to the at least one calibrating endpoint a plurality of harmonics for the at least one parameter, the data pertaining to the at least one calibrating endpoint; and

selecting the endpoint indicator based on the comparing, the endpoint indicator including a selected harmonic for a selected one of the first fundamental frequency, and the second fundamental frequency for a select parameter of said plurality of parameters a harmonic for a parameter from the plurality of harmonics for the at least one parameter.

Amended claim 45 reads as follows.

45. (Currently Amended) A method for detecting an endpoint in plasma processing that employs a plurality of RF signals having a plurality fundamental frequencies at a given frequency, the method comprising:

etching a sample substrate using the plurality of RF signals at a given frequency;

determining a calibrating endpoint by performing an empirical analysis on an etched location of the sample substrate;

etching at least one test substrate at the given frequency using the plurality of RF signals, the at least one test substrate ~~substrate~~ being etched beyond the calibrating endpoint;

measuring a plurality of parameters at least one parameter over a time range when processing the at least one test substrate, the time range including the calibrating endpoint;

comparing data pertaining to a plurality of harmonics of the plurality of fundamental frequencies for the plurality of parameters for the at least one parameter, the data pertaining to the calibrating endpoint;

selecting a given harmonic of a given fundamental frequency for a given parameter from the plurality of harmonics of the plurality of fundamental frequencies for the plurality of parameters as an endpoint indicator based on the comparing, wherein a signal representing the harmonic of the given fundamental frequency for the given parameter is selected from the plurality of harmonics of the plurality of fundamental frequencies for the plurality of parameters as being the signal with the most discernible response pertaining to said calibrating end point selecting a harmonic for a parameter from the plurality of harmonics for the at least one parameter as an endpoint indicator based on the comparing;

setting at least one criterion pertaining to the given harmonic of the given fundamental frequency for the given parameter for indicating the endpoint harmonic for the parameter for indicating the endpoint;

etching a production substrate at the given frequency;

monitoring the given harmonic of the given fundamental frequency for the given parameter when etching the production substrate; and

signaling the endpoint when the at least one criterion is met.

It is respectfully submitted that when multiple fundamental frequencies are present (e.g., 2MHz and 27 MHz in the example above), the cited art, alone or in combination, does not disclose or suggest that the selection of the endpoint signal should be predicated upon the selection of the correct starting point, i.e., the correct fundamental frequency, before its harmonic and the monitored parameter is selected.

It should be pointed out that there is a discussion of monitoring various harmonics of voltage/current/phase of a given fundamental frequency to determine which harmonic signal of that fundamental frequency would yield the clearest end-point shift, and then use that harmonic of that parameter (e.g., the second harmonic of voltage) to perform endpoint detection. However, the claimed invention of amended independent claim 35 and 45 differ from the cited art in that the invention not only selects the right harmonic and the right parameter, but also to pick the right starting point, i.e., the right fundamental frequency.

In contrast, the cited art simply addresses a single fundamental frequency situation, and proceeds to disclose that by picking the right harmonic and the right parameter, endpoint detection may be accomplished.

At least for the above reason, it is respectfully submitted that amended independent claims 35 and 45, as well as their dependent claims, are novel, nonobvious, and patentable over the cited art, alone or in combination.

#### **Claims 36 and 50**

Claims 36 and 50 further recite the use of a narrower time window (discussed as time-bracketing in the specification in paragraphs 28 and 32. Since the endpoint on the sample substrate is determined empirically (using an independent technique such as SEM as discussed in paragraph 26), it is possible to determine roughly when the endpoint should occur.

This knowledge may then be used to create a time range during which the search for endpoint indication in the waveform that is the chosen harmonic of the chosen fundamental frequency for the chosen parameter is performed. In this manner, it is unnecessary to search the entire waveform that is obtained during the etch. Instead, only a predefined time range is searched. In this manner, computational requirement is substantially reduced and efficiency is improved.

As stated in claim 36:

36. (Currently Amended) The method of claim 35 wherein the at least one time range is predefined and is less than a time duration required to etch the test substrate, ~~the endpoint indicator is the harmonic for the parameter, the endpoint indicator to be used for the plasma processing at a given frequency of the at least one frequency.~~

As stated in claim 50

50. (New) The method of claim 45 wherein the time range is predefined and is less than a time duration required to etch the at least one test substrate.

It is respectfully submitted that none of the cited art, alone or in combination, discloses this feature in the manner claimed. For this reason, claims 36 and 50 should be deemed novel, nonobvious, and patentable over the cited art.

**Conclusion**

In view of the discussion herein, Applicants believe that all pending claims are allowable and respectfully request a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at 408-213-9540.

Applicant petitions for (2) two-month(s) extension of time and encloses a credit card payment form in the amount of \$450.00 in payment of the extension of time request. However, the Commissioner is authorized to charge any fees beyond the amount enclosed which may be required, or to credit any overpayment, to Deposit Account No. 50-2284 (Order No. LMRX-P037/P1258).

Respectfully submitted,

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